STRUCTURAL DESIGN WORKSHEET

- **Design loads** must be shown on construction documents:

Floor area use	live load shown
______________	__________PSF
______________	__________PSF
______________	__________PSF
______________	__________PSF

Are live load reductions used? _______

Building is in ____________ county

Ground snow load P_g = ______ PSF (1608.2)

Snow load importance factor I_s = _____ (1608.3.3)

Snow load exposure factor C_e = ______ (1608.3.1)

Sloped roof/flat roof factor C_s = _______ (1608.4)

Roof thermal factor C_t = _______ (1608.3.2)

Roof snow load from the above ground snow times adjustments is ____ PSF = $P_g\ 0.7(I_s)C_e(C_s)C_t$

- ❑ Unbalanced or sliding or drifting snow locations and amounts are clearly shown on plans and calculations (1608.6 to 1608.9).
- ❑ Impact or concentrated load locations & amounts are shown on plans and in calculations (1607).

- **Wind** load resistance design method used? *ASCE 7* or *IBC 1609.6 Simplified for Low Rise*

Amount of openings on each side are: North _____ East _____ South _____ West _____

Amount exterior wall on each side are: North _____ East _____ South _____ West _____

Is building Open, Partially Enclosed, or Enclosed? __________ Worst case is ____% openings

Width of end zone = _____feet edge strip calculation =

Coefficients used

C_f	**Windward Wall**		**Leeward Wall**		**Windward Roof**		**Leeward Roof**	
	End zone	Interior zone	End zone	Interior zone	End zone	Interior zone	End zone	Interior zone
MWFRS								
Components & Cladding								

Wind load importance factor (I_w) = ______ Building use is importance category _____

Exposure category

terrain is ____________________	North __________	K_z = _______
terrain is ____________________	East __________	K_z = _______
terrain is ____________________	South __________	K_z = _______
terrain is ____________________	West __________	K_z = _______

Gust effect factor G = _______ Wind directionality factor K_d = _______

Earthquake design data:

Spectral response coefficients S_{DS}________ & S_{D1}________ (1615.1)

Seismic use group Category_________ (1616.2) Site Class___________ (1615.1.5)

Seismic Design Category___________ (1616.3)

- **Soil & Foundation** design data:

Allowable load bearing value of soil ________ PSF (1804) Presumptive or tested? (circle one)

- ❑ Soil report is *provided* or soil report is *needed* (1802.6) to verify design.
- ❑ Frost protection minimum depth of footings is met (1805.2.1).
- ❑ Slope protection or setback is met for footings (1805.3).
- ❑ Footing design & construction of permitted materials is met (1805.4).
- ❑ Piles or piers meet all general requirements (1807.2.8 to 1811).

Thickness & height of foundation wall supporting unbalanced backfill (1805.5.1.2) __________.

- **Concrete** strength specified ________psi Designed per ACI 318? *Yes* or *No* (circle one)

- **Masonry** properties [material, thickness, and type (hollow or solid)] _____________________

Lateral supports of masonry wall (2109.4)_________________ mortar type ____________

- ❑ Masonry veneers bonding with wall ties meets spacing & materials? (2109.6.3.1)
- ❑ Anchorage of masonry to structural elements (roof or floor to masonry) adequate? (2109.7)
- ❑ Details of bearing on masonry or of masonry bearing on other materials (type & size needed).
- ❑ If using engineered masonry, then complete masonry calculations are to be submitted. (2107 & 2108)
- ❑ **Fireplaces** (2111) materials, construction, and exterior air (2111.16) requirements met.
- ❑ Masonry **Chimneys** (2113) materials, construction, lining, and termination requirements met.
- ❑ Flue area (2113.15 & 2113.16), multiple flues (2113.14), chimney clearances, and locations of fireblocking (2111.14 & 2113.20) are met.

- **Steel**

Construction design? *LRFD* (load & resistance factor) or *ASD* (allowable stress) or *AISC-HSS*

❑ Steel joists (2206) follow SJI specifications showing series, bearing conditions, and bracing.

❑ Welding (2208) and bolting (2209) details followed are noted on plans or in specifications.

❑ Tables 2211.1(1)&(2) steel studs shear wall values are met.

- **Wood Construction**

Yes or *No*

❑ Wood construction quality and labeling of materials used shown on plans as required (2303).

❑ Computations for sizing is based on net dimensions, not nominal member sizes (2304.2).

❑ Wall, floor & roof framing meets provisions of Section 2308 unless a design is specified.

❑ Sheathing Table 2304.6.1 (wall) and floor & roof Tables 2304.7(1), (2), (3), (4)&(5) are met.

❑ Follow fastener schedule 2304.9.1 for minimum number & size of nails (staples allowed).

❑ Heavy timber connections are properly detailed on the plans (2304.10).

❑ Decay and/or termite protection where required for wood (2304.11).

Uses *conventional light-frame construction* method of Section 2308, while meeting all seven limitations:

- ❑ maximum 3 stories
- ❑ maximum 10’ floor-to-floor height
- ❑ average dead load < 15 PSF
- ❑ floor live load does not exceed 40 PSF
- ❑ ground snow load does not exceed 50 PSF
- ❑ trusses do not span over 40’ between supports
- ❑ seismic category D building meets Section 2308.12.6 limits.

Limitations of wood shear walls & diaphragms to resist wind, seismic & other lateral loads meet:

- ❑ Principals of mechanics (2305.1.1).

- ❑ Boundary elements [chord & collector framing] (2305.1.2).

- ❑ Openings in shear panels (2305.1.3).

- ❑ Positive shear panel connections provided (2305.1.4).

❑ Exception met permitting wood assembly to resist horizontal seismic forces from masonry.

❑ Deflection is considered in wood diaphragm designs (2305.2).

- ❑ Shear panel construction

Diaphragm aspect ratio (length to width) of horizontal or sloped diaphragm is ____ (Table 2305.2.3).

Diaphragm aspect ratio (length to width) of shear wall diaphragm is ____ (Table 2305.3.3).

- ❑ Shear wall width (2305.3.5) is measured between overturning restraints (2305.3.6) in load path.
- ❑ Shear wall openings clearly show force transfer around openings (2305.3.7.1) or not (2305.3.7.2).
- ❑ Summing of shear capacities has been limited per section 2305.3.8 (or an exception specified).
- ❑ Using Load and Resistance Factor design in accordance with ASCE 16? (2307)

Section 2306 Allowable Stress Design special provisions are as follows:

- ❑ Table 2306.2.1 values were substituted for 1.15 repetitive member factor for 16"o.c. 2x studs.
- ❑ Shear capacities of Table 2306.3.1 may be increased by 40% in wind design only (2306.3.1).
- ❑ Panel sheathing joints in shear walls shall occur over studs or blocking (2306.4).
- ❑ Shear capacities of Table 2306.4.1 may be increased by 40% in wind design only (2306.4.1).
- ❑ Particleboard shear walls attachment and allowable values designed per Table 2306.4.3.
- ❑ Fiberboard shear walls attachment and allowable values designed per Table 2308.9.3(4).
- ❑ Gypsum board or lath & plaster shear wall design values per Table 2306.4.5 (& Chapter 25 construction).

Instructions for STRUCTURAL DESIGN WORKSHEET

- **Design loads** must be shown on construction documents:

This note above is meant as a reminder that the loads must be shown on the plans, not just found in the structural calculations. As the contractor, owner, building inspector, and component designers may need this information, even though they may not need the all of the calculations. This worksheet contains a partial summary of the input values used in your structural calculations.

This should match the application form info.

Floor area use	live load shown
_______________	___________PSF
*(example: **Offices**)*	____***50***____PSF
____***Retail***______	____***100***___PSF
_______________	___________PSF

1607.9 Are live load reductions used? __***NO***__

Building is in ____________ county

Ground snow load P_g = ______ PSF (1608.2)

Snow load importance factor I_s = _____ (1608.3.3)

Snow load exposure factor C_e = ______ (1608.3.1)

Sloped roof/flat roof factor C_s = _______ (1608.4)

Roof thermal factor C_t = _______ (1608.3.2)

These are all used in finding roof snow load, here.

Roof snow load from the above ground snow times adjustments is ____ PSF = $P_g\ 0.7(I_s)C_e(C_s)C_t$

- ❑ Unbalanced or sliding or drifting snow locations and amounts are clearly shown on plans and calculations (1608.6 to 1608.9).

IBC requires many more special load cases to be investigated to show compliance. Above check box is a reminder to show each of those cases in the structural calculations and to note worst case loads on plans.

- ❑ Impact or concentrated load locations & amounts are shown on plans & calculations (1607).

This is no change from past practice, but just another reminder to clearly show these on the plans.

- **Wind** load resistance design method used? *ASCE 7* or *IBC 1609.6 Simplified for Low Rise*

The answer to this question above will determine from which source the pressure coefficients to be used will come. If the second choice is circled, it also must match the criteria to use that method. Those criteria are: 1. Simple Diaphragm Building (as defined in IBC 1609.2) and 2. not located on the upper half of an isolated hill or escarpment meeting any of the conditions noted in IBC 1609.6.1 listing.

Amount of openings on each side are: North _____ East _____ South _____ West _____

Amount exterior wall on each side are: North _____ East _____ South _____ West _____

The above two items can be taken from the Exterior Wall Opening Worksheet or directly calculated from the elevations shown on the building plans. Note that ASCE 7 considers (opened by human effort) doors, operable windows, air intakes & exhaust openings for HVAC, flexible & operable louvers, gaps around doors, and deliberate gaps in cladding which may be open during a design wind, to be counted as open.

Is building Open, Partially Enclosed, or Enclosed? __________ Worst case is ____% openings

The above question is answered by dividing the opening area by the wall area for each side and by using definitions for "Building, open" & "Building, partially enclosed" which include some minor calculations.

The end zone and edge strips are defined in IBC 1609.6.3 and as a notation in figures found in ASCE 7.

Width of end zone = _____feet edge strip calculation =

Coefficients used

C_f	Windward Wall		Leeward Wall		Windward Roof		Leeward Roof	
	End zone	Interior zone	End zone	Interior zone	End zone	Interior zone	End zone	Interior zone
MWFRS								
Components & Cladding								

Coefficient values to be used will be taken from ASCE 7 Figure 6-3 through Figure 6-9 for enclosed or partially enclosed buildings. Your calculations should match these values. If using design exceptions, then you should enter proper values for pressures (in PSF) for each of the above parts of the table from the corresponding tables in either "ASCE 7 simplified method" or "IBC 1609.6 simplified method" respectively [for MWFRS (Main Wind Force Resisting System) and for cladding & component pressures].

Wind load importance factor (I_w) = ______ Building use is importance category _____

Exposure category
terrain is ____________________ North _________ K_z = _______
terrain is ____________________ East _________ K_z = _______
terrain is ____________________ South _________ K_z = _______
terrain is ____________________ West _________ K_z = _______

Note that it is possible to have different exposure factors from different wind directions. Thus structural calculations for wind resisting systems in the building to resist a wind from the north/south direction could have two different results, one from the north and one from the south. Depending on building geometry, both cases may be needed. For example a mono-slope roof building may have a higher exposure factor on the low wall, causing increased girt sizing for component & cladding and have the MWFRS be more critical from the high wall side, even with the lower exposure factor.

Gust effect factor G = _______ Wind directionality factor K_d = _______

All of the above factors will apply if using ASCE 7 for design, but some will not be needed when using the IBC 1609.1 simplified method. All limits on the simplified method must be met or else that method is not valid for use, thus it will be rejected by plan reviewer and will require that it meet the full ASCE 7 design.

- **Earthquake** design data:

Spectral response coefficients S_{DS}_______ & S_{D1}_______ (1615.1)

The map values of S_S & S_1 in the Code are taken for the location and these 2 values are calculated.

Seismic use group Category________ (1616.2) Site Class__________ (1615.1.5)

Seismic Design Category__________ (1616.3)

This group is determined through method in IBC 1616.2 comparing the building use to those found in the importance factor in Table 1604.5.

This value can be determined through the calculations by method in IBC 1615.1.5 or can be assumed to be Class D [per IBC 1615.1.1] when no soil evaluation is done.

The last blank to fill-in is the <u>Seismic Design Category, this is the most important.</u> The information found in the other four blanks is used to determine that category. If the Design Category is A, then no further seismic design calculation is required for your building. Further design is needed for categories B to F. ***Exception: IBC Section 1615.1 provides that structures located north of the 4%g contour line as shown in IBC Figure 1615(2) or in COMM Figure 62.16-2 [alternate 4%gcontour line] shall be assigned to Seismic Design Category A and need only comply with the requirements of Section 1616.4.***

This value is found by soil test, submit a copy or else by IBC Table 1804.2.

- **<u>Soil & Foundation</u>** <u>design data:</u>

Allowable load bearing value of soil _______ PSF (1804) Presumptive or tested? (circle one)

- ❑ Soil report is *provided* or soil report is *needed* (1802.6) to verify design.

Plan reviewer will likely question any value over 3000 PSF

- ❑ Frost protection minimum depth of footings is met (1805.2.1).
- ❑ Slope protection or setback is met for footings (1805.3).
- ❑ Footing design & construction of permitted materials is met (1805.4).
- ❑ Piles or piers meet all general requirements (1807.2.8 to 1811).

The code contains many empirical tables for this limit.

Thickness & height of foundation wall supporting unbalanced backfill (1805.5.1.2) _________.

All of the check boxes above are provided for the designer to verify that he or she has thought of each of these items, as code officials may be looking at these in reviews & inspections.

- **<u>Concrete</u>** strength specified _______psi Designed per ACI 318? *Yes* or *No* (circle one)

This basic information is needed in the calculations, but also on the plans or in a specification book.

List here all that apply.

- **<u>Masonry</u>** properties [material, thickness, and type (hollow or solid)] ____________________

List here all that apply.

Lateral supports of masonry wall (2109.4)________________ mortar type ___________

- ❑ Masonry veneers bonding with wall ties meets spacing & materials? (2109.6.3.1)
- ❑ Anchorage of masonry to structural elements (roof or floor to masonry) adequate? (2109.7)
- ❑ Details of bearing on masonry or of masonry bearing on other materials (type & size needed).

All of the check boxes above are provided for the designer to verify that he or she has thought of each of these items, as code officials may be looking at these in reviews & inspections.

- ❑ If using engineered masonry, then complete masonry calculations are to be submitted. (2107 & 2108)

The building designer is responsible for masonry fireplace and masonry chimney design, thus it must be included in the initial building plan design and calculation submittal. This is not something that an HVAC designer could submit at a later date, as all structural requirements are ultimately the building designer's responsibility. Building designer can & should work together with HVAC designer on the need for these.

- ❑ **Fireplaces** (2111) materials, construction, and exterior air (2111.16) requirements met.
- ❑ Masonry **Chimneys** (2113) materials, construction, lining, and termination requirements met.
- ❑ Flue area (2113.15 & 2113.16), multiple flues (2113.14), chimney clearances, and locations of fireblocking (2111.14 & 2113.20) are met.

- **Steel**

Construction design? *LRFD* (load & resistance factor) or *ASD* (allowable stress) or *AISC-HSS*

By circling one of the above will indicate which method was used in your calculations.

- ❑ Steel joists (2206) follow SJI specifications showing series, bearing conditions, and bracing.

- ❑ Welding (2208) and bolting (2209) details followed are noted on plans or in specifications.

- ❑ Tables 2211.1(1)&(2) steel studs shear wall values are met.

Each of these above 3 check boxes serve as a reminder to designers to show adequate detail on the plans.

Wood Construction

Yes or *No*

- ❑ Wood construction quality and labeling of materials used shown on plans as required (2303).

- ❑ Computations for sizing is based on net dimensions, not nominal member sizes (2304.2).

The above two check boxes apply to all wood construction. The next one refers to empirical method of section 2308, which can only be used where meeting seven limitations noted below. Each of the five following may or may not apply to the building design, depending on construction method proposed.

- ❑ Wall, floor & roof framing meets provisions of Section 2308 unless a design is specified.

- ❑ Sheathing Table 2304.6.1 (wall) and floor & roof Tables 2304.7(1), (2), (3), (4)&(5) are met.

- ❑ Follow fastener schedule 2304.9.1 for minimum number & size of nails (staples allowed).

- ❑ Heavy timber connections are properly detailed on the plans (2304.10).

- ❑ Decay and/or termite protection where required for wood (2304.11).

Uses ***conventional light-frame construction*** method of Section 2308, while meeting all seven limitations:

- ❑ maximum 3 stories
- ❑ maximum 10’ floor-to-floor height
- ❑ average dead load < 15 PSF
- ❑ floor live load does not exceed 40 PSF
- ❑ ground snow load does not exceed 50 PSF
- ❑ trusses do not span over 40’ between supports
- ❑ seismic category D building meets Section 2308.12.6 limits.

Use of this empirical method noted above, when applicable, will not require structural calculations. But the plans will then be required to clearly have the specifications and details needed to show that each of the tables for members used and the connection minimums are properly & clearly provided on the plans.

The next requirement deals with wood construction using a diaphragm system for horizontal load resistance. If a rigid frame or braced frame resisting system is used instead of a diaphragm system, then that must be clearly shown in the structural calculations and adequate connection details on the plans. The Lateral Load Resisting System & Connection Worksheet should be used in addition to this checklist to clearly show how compliance with all code requirements is being provided.

Wood shear walls & diaphragms to resist wind, seismic, and other lateral loads limitations of:

- ❑ Principals of mechanics (2305.1.1).
- ❑ Boundary elements [chord & collector framing] (2305.1.2).
- ❑ Openings in shear panels (2305.1.3).
- ❑ Positive shear panel connections provided (2305.1.4).

❑ Exception met permitting wood assembly to resist horizontal seismic forces from masonry.

❑ Deflection is considered in wood diaphragm designs (2305.2).

❑ Shear panel construction

Diaphragm aspect ratio (length to width) of horizontal or sloped diaphragm is ____ (Table 2305.2.3).

Diaphragm aspect ratio (length to width) of shear wall diaphragm is ____ (Table 2305.3.3).

❑ Shear wall width (2305.3.5) is measured between overturning restraints (2305.3.6) in load path.

❑ Shear wall openings clearly show force transfer around openings (2305.3.7.1) or not (2305.3.7.2).

❑ Summing of shear capacities has been limited per section 2305.3.8 (or an exception specified).

All of these above requirements for diaphragm construction are of concern to code officials. Most of these requirements will be needed to be verified to plan examiners, but some may also be questioned by building inspectors. As such, if the compliance is clearly shown on the plans, both code officials will have the information at their fingertips. This saves time for contractors, designers & code officials alike.

❑ Using Load and Resistance Factor design in accordance with ASCE 16? (2307)

Section 2306 Allowable Stress Design special provisions are as follows:

- ❑ Table 2306.2.1 values were substituted for 1.15 repetitive member factor for 16”o.c. 2x studs.

- ❑ Shear capacities of Table 2306.3.1 may be increased by 40% in wind design only (2306.3.1).

- ❑ Panel sheathing joints in shear walls shall occur over studs or blocking (2306.4).

- ❑ Shear capacities of Table 2306.4.1 may be increased by 40% in wind design only (2306.4.1).

Note that when these above substitutions or increases are being used in your calculations, it will help to clearly label where & what increase is being used or substitution is being made (to verify that it is applicable to the place where it is used).

- ❑ Particleboard shear walls attachment and allowable values designed per Table 2306.4.3.

- ❑ Fiberboard shear walls attachment and allowable values designed per Table 2308.9.3(4).

- ❑ Gypsum board or lath & plaster shear wall design values per Table 2306.4.5 (& Chapter 25 construction).

These last three check boxes are cautions for the designer using them. If these non-standard materials are used for wind resisting elements, then the framing & connections must meet all the limitations placed on them by the table headings or footnotes. Plans must clearly indicate adequate load paths for them.